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ABSTRACT

This report offers advice on the strengths and weaknesses of the High Performance Computing and Communications (HPCC) initiative, one of five presidential initiatives launched in 1992 and coordinated by the Federal Coordinating Council for Science, Engineering, and Technology. The HPCC program has the following objectives: (1) to extend U.S. technological leadership in high performance computing and communications; (2) to provide wide dissemination and application of the technologies; and (3) to spur gains in U.S. productivity and industrial competitiveness. Because of the importance of the HPCC initiative to the national well-being, the President's Council of Advisors in Science and Technology (PCAST) established a special panel to advise PCAST on the strengths and weaknesses of the program. The Panel's observations and recommendations relating to four central issues: the program strategy; balance among technology, applications, and infrastructure; program management; and program vision make up the main body of this report. (ALF)

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High Performance Computing and Communications Panel Report

A REPORT PREPARED BY THE
PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY

DECEMBER 1992

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THE PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY

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The Council is currently composed of 13 members, including the Chairman, who provide perspectives from academia, industry, private foundations and research institutes.

HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS PANEL REPORT

A REPORT PREPARED BY THE

PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY

DECEMBER 1992

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THE WHITE HOUSE

WASHINGTON

June 22, 1992

MEMORANDUM FOR THE PRESIDENT

FROM: D. ALLAN BROMLEY

SUBJECT: A PCAST REPORT ON HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS

I am pleased to present a PCAST report on your High Performance Computing and Communications Program. This report was prepared by PCAST member Dr. Solomon Buchsbaum and a panel of industrial and academic experts, and has the concurrence of all PCAST members. This report is presented to you for your information, and no other action is being requested.

In my opinion, it is an excellent assessment of the state of the program. The report presents a program analysis based on strategy, balance, management, and vision. Both constructive recommendations for program improvement and positive reinforcement of successful program elements are contained within the report.

We plan on providing copies of the report to the various Federal agencies who participate in the program. It is my hope that this report will serve as an example of the value that PCAST can bring to the Federal government by performing independent reviews of Federal science and technology programs.

Attachment.

THE WHITE HOUSE

WASHINGTON

August 21, 1992

MEMORANDUM FOR WALTER E. MASSEY

FROM: D. ALLAN BROMLEY Allan

SUBJECT: PCAST REPORT ON HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS

I am pleased to present a PCAST report on the High Performance Computing and Communications Program. The report was prepared by a PCAST panel chaired by Dr. Solomon Buchsbaum. The panel consulted with industrial and academic professionals, and has the concurrence of all PCAST members.

In my opinion, it is an excellent assessment of the state of the program. The report presents a program analysis based on strategy, balance, management and vision. It provides constructive recommendations for program improvement and positive reinforcement of successful program elements. It is my hope that the PCAST recommendations will be given serious consideration by the HPCC participants, and that the recommendations will lead to improvements in the HPCC program.

To further this end, may I suggest that this report be distributed at the next meeting of both the FCCSET Chairmen and Vice Chairmen on Tuesday, September 1, as well as the full FCCSET meeting on Thursday, September 3, 1992.

Thank you for your assistance, and I look forward to seeing you in September.

Attachment

The President's Council of Advisors on Science and Technology

High Performance Computing and Communications Panel Members

SOLOMON BUCHSBAUM
Chairman

RALPH GOMORY
Vice Chairman

Staff

EUGENE WONG
Associate Director for Industrial Technology
Office of Science and Technology Policy

High Performance Computing and Communications Panel Report

Introduction

In FY92, a presidential initiative was launched, aimed at securing U.S. preeminence in high performance computing and related communication technologies. The initiative, entitled High Performance Computing and Communications (HPCC), is one of five initiatives coordinated by the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) process. Nine federal agencies are currently involved, with the Defense Advanced Research Project Agency, the Department of Energy, the National Aeronautics and Space Administration, and the National Science Foundation providing the principal program funding and direction. Lesser but important roles are being played by the National Oceanic and Atmospheric Administration, the National Institute of Standards and Technology, the Environmental Protection Agency, the Department of Education, and the National Institutes of Health.

The stated goal of the initiative is threefold: extend U.S. technological leadership in high performance computing and computer communications; provide wide dissemination and application of the technologies; and spur gains in U.S. productivity and industrial competitiveness, all within the context of the mission needs of federal agencies. The strategy for accomplishing the goals and the program components are highlighted in the report *Grand Challenges: High Performance Computing and Communications*, published as a supplement to the fiscal year 1992 and 1993 budgets.

Because of the importance of the HPCC program to the national well-being, especially its potential implication for industrial competitiveness, the Assistant to the President for Science and Technology has asked that the President's Council of Advisors in Science and Technology (PCAST) establish a panel to advise PCAST on the strengths and weaknesses of the HPCC program. The Panel, which includes two PCAST members and experts drawn from industry and academia, has conducted several fact finding meetings, interviewed HPCC program managers from the key participating agencies, and was briefed by the Computer Systems Policy Project, a private sector organization representing all the major American computer and information systems corporations. On this basis, the Panel offers the following observations and recommendations.

Panel Observations and Recommendations

The Panel believes that, in general, the program has important objectives and is structured to achieve the objectives. The Panel also finds that the HPCC program is making excellent progress towards achieving the program objectives.

The Panel's observations and recommendations relate to the following issues: the program *strategy*; the program *balance* among technology, applications, and infrastructure; the program *management*; and the program *vision*.

STRATEGY

The HPCC program has certain explicit technology goals. The two best known goals are to implement by 1995 a tera-ops (1012 operations per second) computer and a skeletal gigabit (109 bits per second) National Research and Education Network.

The Panel finds the strategy of using scalable, massively parallel architectures to achieve the tera-ops goal convincing. Evidence to-date lends credence to the viability of the approach. The potential of the scalable, massively parallel computer architectures exceeds that of any competing choice.

The National Research and Education Network (NREN) approach of coupling diverse existing networks, for example, the DARPA, NSF, and DOE networks, is also proving to be effective. The Panel supports the strategy of making NREN both an infrastructure goal and a testbed for technology development.

The integration of computing and communication as manifested in the program is viewed by the Panel as a critical part of its strategy. It will do much to accelerate the Nation toward a "digital society." However, the integration of computing and communication also creates enormous challenges for data handling and analysis. Therefore, the Panel recommends that special attention be given to database standardization for ease of utilization.

An effort should be made to encourage additional federal agency participation in the program. The participation of the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), the National Institute for Standards and Technology (NIST), the National Institutes of Health (NIH), and the Department of Education (DoEd) is important, and their role should be continually expanded.

The purpose of NREN is threefold: to satisfy the Government's critical needs for networked computing, to provide a high speed data communication service for the research and education community, and in doing so, serve as a testbed for the development of network technologies and services. The NREN is not intended to "grow" into a commercial network, nor is NREN designed to serve as an all-inclusive educational network. Here, the meaning of "network" is functional, not physical. The optical-fiber physical medium and broadband switches will be owned by common carriers, and the "network" will be implemented by purchasing services from common carriers and other commercial vendors of communications services.

Because of this close relationship with the private sector, there is a special opportunity to stimulate commercial exploitation of products and services developed in conjunction with the NREN program. The Panel recommends that a comprehensive study be made on the technical, financial, legal and regulatory problems associated with the commercialization of a nationwide high-speed network to maximize the catalytic effect of NREN. Furthermore, it is critically important to be paying attention to ways in which the common carrier industry can be involved now, along with the other players, in planning how to help a nationwide high performance information infrastructure become effective and commercially viable as soon as possible.

In order to position the United States to take advantage of the evolving computing and communications infrastructure, we must develop a broad approach to the use of and familiarity with high performance computing and communications. In addition to the program of increased support for research and graduate education contained in the original HPCC program plan, the Panel recommends increased emphasis on programs to foster the growth of computational science research

and education. These programs will need not only to foster capability in traditional computer science, but also to stimulate the use of HPCC in the computational solutions to problems in science, engineering, and other fields.

A dialogue between the HPCC program and industry is essential to the success of the initiative. Without program acceptance by the various industrial constituencies, the results of the program will have little impact. Acceptance by industry depends on strong industrial participation. The HPCC program has successfully included input from industry to date, and the panel recommends that the dialogue between the HPCC program and industry be continued and strengthened as the program evolves.

Balance

Comments on the distribution of funds among the four program components are limited by the Panel's inability to discriminate between hardware purchases and other program tasks. Furthermore, since the program is in the early stages of implementation, it is expected that significant funds earmarked for Advanced Software Technology and Algorithms (ASTA) and Basic Research and Human Resources (BRHR) are being used for one time purchase of hardware. Therefore, the Panel's comments do not address the balance of spending between the various program components.

The Panel believes that the High Performance Computing Systems (HPCS) component overemphasizes processing speed relative to other computing needs, for example, memory storage, visualization, and user interface. These technologies enable the user to manipulate the vast amount of information generated by the enhanced computational capabilities of scalable, massively parallel computers. Steps should be taken to ensure that all computing components receive adequate emphasis to allow for the full exploitation of the tera-ops processing capability.

Some agencies may be overemphasizing support for existing constituencies over program objectives. Optimal achievement of program objectives should be the primary determinant of implementation tactics.

In particular, the Grand Challenges should drive the technologies. Agencies should be encouraged to choose Grand Challenges and support them to ensure success. Because the implementation of the Grand Challenges will uncover program deficiencies, these data should be used to assist in the redirection of the program objectives, in particular, with the HPCS and NREN components. Indeed, several of the panelists believe that the successful realization of the Grand Challenges constitutes a more important goal than the development of the supporting technologies.

NOAA, EPA, NIST, NIH, and DoEd engage in research and development which would be substantially advanced by the application of HPCC technology. These agencies should continue to identify and undertake Grand Challenges appropriate to their missions.

MANAGEMENT

The Panel believes that the level of coordination during the planning phase of the initiative was commendable. For example, the HPCS technology development effort, jointly implemented by DARPA, DOE, NASA, and NSF has very little overlap and is effectively addressing the major problems in a coherent manner.

It is the Panel's view that there are no formal structures to expedite program review and to discuss program changes during the implementation phase. Program execution is not reviewed collectively to permit timely program modifications. An effort should be made to implement the level of program coordination during implementation that was achieved during program planning.

The Panel suggests, as a test case to foster more tightly coordinated execution, that each agency could contribute a small portion of their budget, perhaps five percent, toward the funding of a single, coherently-managed project. The project should be well-defined, and in support of a highly visible Presidential initiative, e.g., a model of ozone degradation for the Global Change initiative.

VISION

The Panel believes that, successfully implemented, the HPCC initiative will significantly accelerate the advance toward a "digital information society" in which computing and communications are combined in a seamless manner to change our lives in profound ways. The Panel believes that this vision has a good chance of being realized. This vision is widely shared even among those who do not understand the technical details, and accounts for the strong interest and support that HPCC enjoys.

A unification of computing with communications is inherent in the HPCC strategy. In NREN, networking makes the power of a single computing resource available to many users. In massively parallel computing systems, speed is achieved by making it possible for many processors to work on a single problem in an efficient way through sophisticated inter-processor communication. Thus, computing is made available in both "one for many" and "many for one" modes of operation, thanks to effective communication technology.

The long awaited synthesis between communications and computing technologies will have an impact that transcends the development of the technologies themselves. It will be another significant step in the transformation of our society through information technologies.

REPORTS

The President's Council of Advisors on Science and Technology has produced reports on a variety of science policy topics. Copies of the following reports may be obtained free of charge from the Office of Science and Technology Policy, Executive Office of the President, Washington, D.C. 20506; (202) 395-4692.

Achieving the Promise of the Bioscience Revolution: The Role of the Federal Government
Daniel Nathans, Chairman

High Performance Computing and Communications Panel Report
Solomon Buchsbaum, Chairman

LEARNING to Meet the Science and Technology Challenge
Peter Likins, Co-chairman
Charles Drake, Co-chairman

Megaprojects in the Sciences
John McTague, Chairman

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